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# “Introducing STEAM Disciplines in Early Childhood Education: Intervention Plan”

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**Isabel Dorado Jiménez**

Salvador Reyes de Cózar

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## **Abstract**

In view of the actual changing outlook of the labour market, partly caused by the progress of technology, it is expected that, in 2030, around 85% of the jobs that current students of the educational system will perform are unknown to date, they have not yet been created (Institute for the Future for Dell Technologies, 2017). Which the only certainty that jobs will continue to be linked to the development of technologies and scientific areas of knowledge and looking toward a parallel development of the educative and economic sectors, arises the STEM approach in education, which combines the teaching of four disciplines: science, technology, engineering and mathematics; and, later, STEAM, which incorporates artistic disciplines, and mainly creativity, for the development of science and technology.

The objective of this Final Project Work is to design an intervention plan which introduces the STEAM disciplines in the Early Childhood Education stage in an integrated way, just the way they are in reality. Learning of these disciplines is expected to provide, in addition to scientific and technical knowledge, situations in which students can develop 21<sup>st</sup>-century skills and the ability to think outside the box. The intervention plan is organized into nine sessions, each of which has its own mini-project entity based on a traditional or current fairy-tale, which orchestrate the different tasks in the form of challenges or problems to solve in order to help the characters. In case of future implementations of the STEAM approach, other disciplines, such as reading or entrepreneurship, could be integrated into this formula so as to offer students a holistic and integral development of their learning and skills' acquisition.

## **Key Words**

STEM, STEAM, Multidisciplinary, Art, Storytelling, Early Childhood Education.

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## **1. Introduction**

Education is considered a key factor in the progress of people as individuals and those communities to which they belong. Hence, it could be assumed that education should meet the demands of society in terms of providing students with the abilities, knowledge and attitudes necessary regarding reality. However, the relation between Education and reality is not that easy. Educational systems have not kept pace with the changing character of work. As a consequence, it has been reported that employers are having problems finding workers adequately prepared (Peralta-Alva & Roitman, 2018). It is not shocking taking into account the difficulty of getting adapted to jobs which have not been invented yet. In particular, around 85% of the jobs that learners will be doing in 2030 are unknown (Institute for the Future for Dell Technologies, 2017).

In this sense, at the present time, despite scientists, technologists, engineers and mathematicians are seen by governments all around the world as a sign of economic prosperity, there exists a gap in technical skills related to those areas of knowledge (Bell, 2016). Just a small percentage of learners are interested in the aforementioned disciplines, and many of them will end up dropping it out beyond compulsory schooling due to the challenges, effort and difficulties that entail its study (Felder & Brent, 2016). But, fortunately, there are still believe that there are ways to help students to improve their desire and ability to master tough subjects.

Thus, in a present situation in which the evolution of professional activities poses an uncertain future, the relationship between education and jobs should be one of the backbones of educational planning (Planas, 2018). However, while jobs have been being created and destructed due to Globalization and technology; Education systems have remained static (World Economic Forum, 2017). In this way, the difficulty of the changing nature of the

current world of work, which the only certainty is that it will continue to be linked to the development of technologies and scientific areas of knowledge, is added to the aggravating circumstance that education is years behind. There has been no parallel development of both sectors.

Notwithstanding, the situation has become even more complex. There is a strong need for people with technical training, as said before, who also have creative skills as well as innovative capacity (Taylor, 2016). In this regard, arts are considered a way of developing these competencies as well as thinking on a problem in a variety of ways. Nonetheless, contrary to current needs, in Educational curriculum arts have not been included in those global approaches which affect the rest of subjects and they have even been considered subjects of second category, less valued than the core subjects in different educational levels. Besides, it has been reduced to the reproduction of products instead of creation, since in the Spanish curriculum for Early Childhood Education (*Orden de 5 de agosto de 2008, por la que se desarrolla el Currículo correspondiente a la Educación Infantil en Andalucía.*, 2008), more emphasis is given to the enjoyment, appreciation, respect and representation of the best of universal art. In such a way, educational agencies are urged to make a special emphasis in creativity establishing real connections with the other disciplines since their combination brings greater benefits than their learning in isolation (Peralta-Alva & Roitman, 2018).

From the necessary evolution of Education in line with the arguments just presented and the also necessary relationship between Education and the changing working world arises the STEM approach in education, which combines the teaching of four disciplines: science, technology, engineering and mathematics; and, later, STEAM, which incorporates artistic disciplines for the development of science and technology. This integrative approach across five different disciplines also focuses on talent development, placing skill acquisition on the

same level as knowledge. Some of the skills that STEAM seeks to develop are problem-solving, communication, collaboration or creativity.

In light of this situation, the present intervention program intends to set forth a proposal for an intervention program to include the teaching of STEAM areas in early childhood education. Therewith, it is intended to come up with an educational plan which exposes children of this stage to these five disciplines, creating significative relations among them and allowing them to experiment and create giving especial importance to the arts throughout the whole process. That way, children are expected to be involved in learning these areas so that they perceive it as a pleasant activity. Finally, this intervention plan has been thought to pursue a positive effect in integral development, acquisition of competencies and social active participation of children which must positively revert to their immersion in the future and unforeseeable labour market.

## **2. Theoretical Framework**

### **2.1. Definition and origin of STEM**

The acronym STEM stands for Science, Technology, Engineering and Mathematics. It is an educational approach which is gaining more and more relevance due to the reason that talking about STEM is talking about real life. Despite this increasing interest in STEM education in recent years, this acronym was first coined in the USA during the 1990s by the microbiologist R. Colwell during her directorship in the National Science Foundation to highlight the importance of these four disciplines (Shaikh, 2019) as a response to the possible fall of the country in the global economy, said Friedman (Kelley & Knowles, 2016).

The wealth of a country is based on many factors such as Education which should provide students with a meaningful preparation for the future (Dugger & Tech, 2010). STEM

disciplines are present in all dimensions of today's life, and that is why the educational approach based on these disciplines comes into play to offer students an education that meets the expectations and needs. Science, which is concerned with understanding the natural world (NRC, 1996), is present in such controversial issues as it is global warming or medicine's progress. This natural world studied by Science is modified by Technology so as to meet human needs (Dugger, 2000), so that its presence cannot be denied in the digital age. Engineering combines mathematical knowledge and Science's understanding of the natural world for the benefit of society (Gorham et al., 2003), consequently is essential in terms of facilities and design. Finally, mathematics is a natural activity (Widada, Herawaty, & Lubis, 2018) which covers fields as important as economics and serves as a common language for fields interaction. Such is the incidence of these disciplines that the demand of people who posse skills related to STEM in the labour market is increasing to such an extent that employers do not found applicants who meet the requirements (Kautz et al., 2018; OECD, 2017).

In that way, STEM as an educational approach was seen as a priority tool for the increasing of STEM careers students, STEM capable workforce and STEM literacy among all students (Guzey, Moore, & Harwell, 2016). So that, it can be understood that STEM was conceived for both an economic and an educative aim. From the beginning, to achieve that last aforementioned aim, the STEM approach followed the constructionist theory of knowledge, which defends that learning is built through person's dynamic interaction with the world in which they are (García, Reyes, & Burgos, 2017).

Regarding the definition of this educational approach, many authors agree that the teaching contents of the four disciplines are closely related (English, 2017; Kelley & Knowles, 2016; Zhai, 2019); which allows to bring them together in a context based on real-



life problems and enriches children's learning (Kanadli, 2019). Furthermore, the main outcomes set for STEM towards students are to develop positive attitudes towards the disciplines; to enable them to transform knowledge and skills into STEM products, inquiries and designs; to increase academic achievement and to improve the 21<sup>st</sup>-century skills (Kanadli, 2019). By acquiring these tools and taking into account that STEM awakes motivation to create, built, invent, experiment, solving problems and innovate; learners are expected to be able to face critical problems of the society.

Bearing in mind the previous premises, a definition which seems to be especially accurate is the following one (English, 2017; Guzey et al., 2016; Shaughnessy, 2013): “STEM education refers to solving problems that draw on concepts and procedures from mathematics and science while incorporating the teamwork and design methodology of engineering and using appropriate technology”. This interpretation leads to the use of problem-solving as a learning method, among others, so as to make children flexibly apply knowledge and skills (Zhai, 2019).

### **2.1.1. STEM as a cross disciplinary approach**

Even if there is no consensus, given the most recent definitions of STEM, integrated STEM seems to be the most coherent form of it. Entities such as The International Technology and Engineering Educator association consider STEM as a cross-disciplinary approach to school subjects which includes the disciplines of science, technology, engineering and mathematics in an integrated manner (Dugger & Tech, 2010). Going a step further on the interpretation of this educational term, the STEM Task Force Report (2014) acknowledges that STEM not only integrates the four disciplines but also encompasses the real world and problem-solving based learning. Thus, STEM disciplines should not be taught in isolation, since they are not isolated in the real world.

Given the connection between STEM and reality, when teaching through the STEM approach, meaningful learning context should be provided to students (Bahrum, Wahid, & Ibrahim, 2017). That is, contexts which require solving critical problems similar to the ones faced in the society such as complex economic, social and environmental problems, always adapted to learners' age, should be embedded in schools (English, 2017). Taking that into account, education must enable learners to make connections among the STEM subjects so as to build both knowledge and skills as well as their potential. That way, integrated STEM prepares children to successfully tackle those complex problems (Guzey et al., 2016).

That integration requires the development of action plans. One of the approaches suggests eight different ways of confronting it being flexible and gradual. Different combinations may be done among the disciplines such as science and mathematics or incorporating technology to science or they can be addressed complementing each other in an interdisciplinary way (Bybee, 2013). However, the author himself of these methodological proposals suggests the existence of other approaches which are equally valid since each one has its advantages and disadvantages. Many of them agree in some aspects such as the importance of motivation, learning from failure, student-centered approaches; as well as the development of communicative and teamwork skills (Bybee, 2013; Hurley, 2001). The sine qua non requirement, no matter the chosen approach, is always integration (Guzey et al., 2016).

## **2.2. From STEM to STEAM**

STEM and arts have always been seen as opposite disciplines. Nonetheless, the combination of these disparate disciplines contributes to innovative product design due to the variety and diversity of skills and knowledge with which provides people. As stated by Sousa & Pilecki, STEM leads people to be objective, logical, analytical or useful while arts become

people more subjective, intuitive, and unique (Oner, Nite, Capraro, & Capraro, 2016). Thus, in the words of Kim et al. (Kim, Kim, Nam, & Lee, 2012) “art provides a creative model in the development of science” (p.2). That way, if people in the real-world need skills and knowledge from both kind of disciplines; it is more than reasonable that education includes both STEM and art in the teaching-learning process.

In this debate was South Korea engaged in 2011 when the country decided for the very first time to include arts in the acronym STEM, giving as a result STEAM, which stands for science, technology, engineering, arts and mathematics (Sim, Lee, & Kim, 2015). The rapidly evolving economy was a key factor of this decision. It was realised that divergent thinking was essential to seek multiple solutions to problems; to produce something novel; and to generate a large number of ideas (Oner et al., 2016). As Watson and Watson claimed, Creativity was the answer to reach this necessary divergent thinking since it enhances learners’ creating, inventing, innovating, and engineering capacities (Hunter-Doniger & Sydow, 2016).

It should be noticed that the “A” in the STEAM mostly referred to creativity when the educational approach is analysed (Kang et al., 2013). Apparently, creativity is a combination of talent, knowledge, ability, intrinsic motivation, and personal traits, said Holm-Hadulla (Conradty & Bogner, 2018). What is more, that creativity which emerges from the “A” of STEAM fosters the interplay between left-brain convergent thinking and right-brain divergent thinking aforementioned. It leads to new ideas and solutions to present and future interdisciplinary problems which at the same time let learners become global citizens who have the skills to conquer new challenges (Bahrum et al., 2017).

In brief, STEAM highlight the importance of STEM education, but also the fact that the arts contribute to developing new ways of seeing, thinking and learning (Bahrum et al.,

2017), which is a requisite for today's learning process in terms of adaptation and success to current problems and situations. That way, the importance of art education cannot be denied (Trung & Hong, 2019) and should be foster if open-minded and prepared for meaningful processing ideas learners is what the education system is seeking for (Conradty & Bogner, 2018).

### **2.2.1. STEAM contribution to the 21<sup>st</sup> century skills development**

The 21<sup>st</sup>-century skills are a set of abilities that learners need to develop in order to succeed when facing future challenges which require learning, literacy, and life skills. This term refers to competencies such as collaboration, communication, digital literacy, critical and creative thinking, and problem-solving, social skills or leadership, among others (Bahri, Kusumawati, & Nuraini, 2017). STEAM seems to be a multidisciplinary learning approach which develops those skills inasmuch as it encourages students to make connections between subjects using 21<sup>st</sup>-century skills (Liao, Motter, & Patton, 2016).

The potential of STEM to make students learn in more depth and having fun and experimenting is extraordinary. It also provides sophisticated problem-solving skills. However, according to Daskolia et al., creativity (arts) is one of the most important aspects in this century so as to successfully overcome real problems (Bahri et al., 2017) by developing innovative solutions. Therefore, STEAM is helping students to develop 21<sup>st</sup>-century skills by boosting them to generate and assess new contents, products or designs which makes them master content and, in this context, creativity plays a special role which gives learners the possibility to be an agent of change who contribute to society (Hadinugrahaningsih, Rahmawati, & Ridwan, 2017).

### **2.3. STEAM in Early Childhood Education**

Early Childhood Education children have an inherent disposition towards science due to their sense of curiosity, creativity and persistence. In line with Koester, they need time to explore, create and manipulate so as to gain understanding of how the world works (DeJarnette, 2018). Studies have shown that early childhood is a fundamental stage in education and children's development. Thus, the Boston Children's Museum (Hassan, Abdullah, Ismail, Suhud, & Hamzah, 2018) reports that the sooner young children engage in real-world problem-solving situations applying science, technology, technology and mathematics, the better they will master the associated skills. Likewise, the lack of exposure to STEAM disciplines in the early years may trigger off loss of interest and confidence in STEAM in their future.

On top of that, STEAM education in early years has numerous benefits. Among others, the Early Childhood STEM Working Group highlighted that positive experiences in STEAM fields help learners develop inventiveness, imagination, flexibility, engagement, and confidence (Hassan et al., 2018). Natural and playful environments also promote collaboration and communication which allow students to develop better solutions to challenges applying their STEAM knowledge while discussing among them different strategies and suggestions (Sullivan & Umaschi, 2018). Moreover, facing the STEAM challenge at these ages contributes to mitigate the gender-based stereotypes that exists within the science fields (DeJarnette, 2018).

In terms of how to face this challenge of implementing STEAM education in Early Childhood Education, among the several methodologies which are proposed, such as project, play or inquiry-based learning, there is a key aspect which stands out: hands-on experience (Soylu, 2016). This is precisely the most powerful way of engaging preschoolers since they

have fun, practice problem-solving and interact with digital tools. Furthermore, teachers should question students and encourage them to develop critical thinking about their projects and ways to improve them (Ingram, 2014). Finally, the misguided idea that STEM concepts are too difficult for preschoolers should be removed.

### **3. Research objectives**

Given the current situation and evolution of the labour market, as well as the society, the main objective of this project is developing an intervention plan based on STEM approach from the perspective of fairy tales which fits for a group of 5-years-old Early Childhood Education learners. Based on that general objective, other more specific are set:

- To include a balanced offer of all the STEAM disciplines.
- To design situations which provide students with the necessary skills to manage real situations.
- To prove that STEAM disciplines can be integrated into the educational programming of Early Childhood Education.
- To promote creativity when implementing activities about thinking and creating products, solutions or ideas.
- To offer the student body manipulative, appealing and innovative resources which facilitates the acquisition of STEAM skills and knowledge throughout the development of the intervention plan.

### **4. Program Plan**

#### **4.1. Physical Setting**

This intervention program will be implemented in an Early Childhood Education classroom which belongs to Claret school of Seville. The institution is under the ownership of

Claretian Missionaries, who convey their vision to the life of the centre. Thus, the school is a charter and catholic school which teaches to Early Childhood, Primary, Secondary and Baccalaureate Education's students. The target educational centre is located in the district of Bellavista-La Palmera, in a neighbourhood called Heliópolis. The socioeconomic-cultural context can be considered as medium-high level. Students' parents usually have university studies. In general, the families involved in the school keep a traditional structure.

The centre is characterized by offering an education in the style of San Antonio María Claret, patron of the school, and the Social Doctrine of the Catholic Church; because one of the bases of the ideology is its evangelizing project. Two fundamental pillars are the family and society, social groups close to the students who are encouraged to contribute the best of themselves. Pursuing this aim, it opts for an integral formation and the mission; and numerous projects that are developed from the first courses in Early Childhood Education up to the last ones, corresponding to Baccalaureate. Likewise, special emphasis is placed on the feeling of belonging to a group, which would be the centre. In fact, they consider themselves a big family. Thus, children, teachers and families are often willing to participate in the wide variety of activities organized by the centre. At an individual level, the centre focus on the transmission of an effort philosophy and a critical and committed awareness, as well as values such as honesty, love or healthy self-esteem.

Putting the spotlight in Early Childhood Education, the school invest its efforts in following interdisciplinary approaches which facilitate the promotion of learners' initiative, creativity, motivation and critical thinking. Likewise, they intend to make the students discover the value of cooperative and teamwork. The methodology chosen so as to fulfil these aims is Project-Based Learning, an active method which places the student as the centre of its learning process. Among this and other innovative initiatives, the school acknowledge the

importance of learning how to use TICS in a responsible way and in favour of the enhancement of the society from early ages. Finally, in Early Childhood Education, special attention is given to the game as a powerful development tool and personalized attention to students so that they can benefit from the teaching-learning process adapted to their needs.

#### **4.2. Recipients of the program**

This project could be adapted to any group of 5-years-old children. However, on this occasion, it has been designed and adapted thinking on a specific group. It is a group of the third course of the second cycle in Early Childhood Education with a total of 25 learners, being fourteen boys and eleven girls. All of them have been in school since the age of three. It is important to mention that there is a student with specific necessities of educative support due to a lifelong condition which will be explained further on in this text. Levels of development and maturity from a motor, linguistic and behavioural perspective are quite different among students. In general, they are capable of good behaviour. However, some of them present some problems of low frustration tolerance or difficulties to sustain attention when their peers talk.

It could be said that the group shows to have some autonomy in matters of daily life such as putting on or taking off warm clothes, taking care of their belongings or having breakfast. Furthermore, just like in every group of people, there are entirely different personalities among the students. Some of them are more mature; others have clearly defined leadership skills; there are also students with a lack of emotional control or engagement; among other things. Nonetheless, in general, almost all of them like to participate, are interested in learning and are curious. The relationships among them are positive and they help each other.



They have already acquired almost every phoneme. Moreover, they have control of units of the language such as prepositions, articles or verbal forms, so their speech is completely understandable. Likewise, they can comprehend almost every conversation they listen to, responding to instructions. Concerning reading and writing, in general, children know all the letters and are able to read short sentences as well as write many words even though they make mistakes such as joining two words or changing some letters into another. With regards to mathematics, they control counting and numeric value. Besides, during their years in school, they have experimented with manipulative materials so as to learn about adding, subtracting, measurement and geometry.

The student with educational special needs lives with a moderate cerebral palsy which mainly affects their mobility and hearing. Thus, they need some adaptative technology and resources so as to accomplish daily activities. Regarding their mobility, when starting school, they could not walk but crawl. At this time, they have made progress, being able to move around the classroom using some elements of the furnishing as a reference in case they need support. Actually, at short distances, they are able to move without any support if there are no obstacles. For great distances, by contrast, they need an adapted stroller which helps them to keep a correct posture. In the playground, they use a doll stroller which also serves them as a toy. In relation to their fine motor skills, they have an exceptional motor ability sparsely affected by their disorder. Consequently, even they have to make a special effort, they reach impressive results, being able to accomplish every activity as their classmates.

### **4.3. Methodology**

The target group is used to work through the Project-Based Learning (PBL) methodology. Throughout the school year, they develop three projects, one per term, that address different topics. Moreover, great importance is given to storytelling since it is

understood as a way of promoting reading habits as well as developing imagination and attention; among other benefits. In this line, there is a classroom library which is within children's reach, offering them free access to books. Furthermore, each week, the teacher tells them one or two stories. It is also remarkable that the game is considered as an essential tool for children development and amusement, consequently, it is part of the school life.

On the one hand, PBL is a teaching method that provides learners with the autonomy to learn, explore, and investigate an authentic, engaging, and challenging problem. Those projects integrate activities based on real-world issues and real-life practices which promote learners' work by sustained inquiry (Chiu, 2020). Among the essential design elements of PBL (better known as Gold Standards) are reflection, critique and revision, or student voice and choice. In general, these standards also suggest that there should be a final public product in which fulfilment group work is enhanced. Due to all this, PBL is considered a student-centred learning pedagogy in which teachers are facilitators and guides. Furthermore, PBL is associated with problem-solving skills development, motivation risen, and students' decision making, among other outcomes. Thus, PBL is considered a promising method so as to reach learners' empowerment and the development of 21<sup>st</sup>-century skills (Demink-carthew & Olofson, 2020).

On the other hand, storytelling consists of the creation and narration of stories pursuing a final outcome. Those stories are considered a powerful tool for learning since they achieve a greater degree of engagement interactively allowing learning by doing and experimenting (Niemi, Niu, Vivitsou, & Li, 2018). That way, and taking into account that storytelling promotes sharing ideas, problem-solving and critical thinking skills and cultivates high order thinking skills, it is thought to have a greater impact in learning than other resources (Ramos Villagrasa et al., 2019; Roth, 2015).

In the light of the above-mentioned information, the present intervention program will be project-based taking storytelling as the main resource; selecting the most beneficial aspects of each of the methods. Thus, each session will be considered a brief project which will revolve around the chosen storytelling in which students will have to solve problems that arise in the course of the story. So as to reach a solution or a final product construction, children will have to develop the skills related to communication and group work, among others while implementing STEAM disciplines.

#### **4.4. Sessions of the Intervention Plan**

The present intervention program is planned to be implemented during the third term of the 2020/2021 school year in a 5-years-old classroom of Early Childhood Education, as said before. That third term goes from April 5<sup>th</sup> to June 22<sup>nd</sup>. A session per week will be carried out during that period of time, specifically the sessions will be on Thursdays, being Thursday, April 22<sup>nd</sup> non-school day due to the celebration of the April Fair and Thursday, June 3<sup>rd</sup> bank holiday because of Corpus Christi. Thus, the total number of sessions will be nine sessions of one hundred minutes (Table 1).

Those sessions (Table 2 to 9) will share a common structure which consists of the storytelling of an illustrated album (Table 10) or oral transferred folk stories and hand-on activities in which students will work divided into small groups of four. The suggested activities will put children in front of situations that they will have to solve, for which they will have to face new languages, look for the how or why certain things happen, plan as an engineer would do (in an adapted way) -designing, implementing and evaluating - , among other things. Creativity will be key in the learning process to be successful and make the most of the sessions.

Given that students will be working in groups, each member of the group will have a different role which will be remembered at the beginning of each session: controller (monitors noise level and check that everything leaves clean and tidy); spokesperson (ask, answer and present); coordinator (encourage and check that everyone is working), and secretary (write down and remember the steps to follow). By acquiring these roles, learners will begin to acquire the spirit of teamwork and develop the necessary skills for it. Thus, students will be the center of learning, they must actively participate and share their ideas. On the other hand, the teacher must act as a guide for the student in the development of the sessions. The teacher should guide them, ask them questions that make think, or answer their questions. It is important that, in case of a doubt that the teacher does not know how to solve, they invite the learner to look for the answer together. In addition, for the development of the workshops, it would be advisable for the teacher to have the support of Early Childhood technicians or the students' families to be able to offer students more individualized attention and, therefore, take more advantage of the program.

Finally, regarding resources, it should be added that the different materials which will be made available for learners will be properly tagged so as to help them to identify and recognize the writing of those materials. Besides, some of those resources or the use that may be given to them in the sessions are not common in five-years-old classes of Early Childhood Education. Thus, it is intended that children give them a new and different use that arises from their creativity, their new ideas and conceptions, the desire to try to create something that works and, ultimately, to think out of the box. In relation to technological resources, the proposal includes the use of tablets and programmable robots. The center has had tablets for a year and both students and teachers have already experienced its use in class, so it would be a matter of introducing them to other functions or opportunities of these devices. As for

programmable robots, this resource would suppose a small investment by the center, although not important since currently the market offers economic options.

#### **4.5. Assessment**

This proposal arises when detecting, through experience and observation in the classroom and consultation of previous research, the need to include the most technical disciplines in the Early Childhood classroom in response to changes in the world of work and the reality in which the new generations of students are and will be immersed. This detection was followed by the design and planning of the proposal aimed at a five-year class and, since the evaluation should be considered as one more part of the change process, it should go hand in hand with the proposal and be part of it. Thus, after this initial evaluation, the implementation of the proposal will be unconditionally accompanied by continuous evaluation and, subsequently, a final evaluation.

On the one hand, continuous evaluation will be aimed at detecting progress and difficulties, reflecting on specific moments, collecting the interactions that take place during the development of activities and generating a short-term improvement process that allows changes to be made from one session to the next. The main method of collecting this information will be systematic observation and will be recorded in a class journal. Systematic observation will pay attention to the development of the sessions, the adequacy of the proposed activities, the response of the students to these activities, the degree of creativity that the students put in place to find the best solutions, the adequacy of the materials offered, as well as the quality of peer interactions. Furthermore, bearing in mind that the aim is to integrate the STEAM approach in the classroom, it is considered essential the attitude that the students adopt towards the sessions and their tasks. Thus, at the end of each session, to complete the information extracted from the observation, each student must evaluate the

session through a previously assigned Plickers code (Figure 11), passing through the evaluation corner (Figure 12) and turning the code to leave at the top the emoticon they want to use to express their opinion of the session; the teacher will scan the answers to obtain the information quickly and easily (Josune Rodríguez-Negro, 2019).

Finally, the final evaluation will consist of the assessment of the implementation of the project, its adequacy, as well as the observable results. The tool to be used will be an estimation scale (Table 11) in which the categories or items to be evaluated will be reflected, which will be weighted according to the frequency with which they occur. With this final evaluation, the aim is to conclude if the stated objectives have been achieved, as well as to detect the strengths and weaknesses of the project in order to improve the intervention on future occasions. The recording of the observation carried out during the project will be key to this last evaluation, taking into account the process and not only the final result.

## **5. Results and conclusions**

In the present intervention program, the current outdated situation of education is analysed in relation to the future labour market in which children who are currently enrolled in the basic education stages (Early Childhood Education) will be immersed. This analysis betrayed the need to include the most technical disciplines in the teaching-learning process to equip students with the skills, knowledge and attitudes necessary to achieve success; as well as to meet the expectations of employers who are already having problems filling technical job vacancies today due to the lack of preparation of applicants. From this need arose the proposal for an intervention plan based on the STEM approach, an approach that led to STEAM to enhance the development of creativity in students, an essential capacity for generating new ideas and solutions.

It should be highlighted from this proposal that no discipline prevails over the others since it has been tried to ensure that the offer of activities linked to each of them was balanced. This breaks the tendency to forget engineering and technology when a project based on the STEAM approach is implemented in the early childhood stage (Bers, 2008). With this, it is possible to integrate the four disciplines plus creativity so that holistic learning becomes possible. Furthermore, this is achieved through stories that serve as a backbone for the development of the program.

Given that the teaching methods (PBL and storytelling) that were used in the classroom have been taken into account to base this project, students will have at the same time a certain feeling of stability and security and will experience novelty, since the activities that are going to be developed throughout the program do not resemble those previously carried in the class. In this sense, it should be noted that these activities proposed by the intervention program are student-centered, which allows maximum student participation and, therefore, greater development of knowledge, skills and attitudes. In addition, in relation to the novelty of this program in the classroom, it should be added that, although the students were familiar with tablets, during the sessions they are presented with a new function for which they can use them. They will also have a contact for the first time with programmable floor robots that will represent a range of new possibilities for student learning in the area of technology.

Being an intervention program that would be developed for the first time, the duration has been limited to a single semester with one workshop per week. Although each session is of considerable duration and during the implementation many experiences are accommodated, in the case of a future implementation of the STEAM approach in the classroom, it is advisable to combine it with the rest of the classroom dynamics, so that STEAM stops being something extraordinary to become a regular part of the teaching-learning process just like

other disciplines such as reading. In this line, it should be noted that recent researches have revealed two new terms that have the STEAM approach as their origin. These are STREAM, an approach in which the R is for reading (Mitts, 2016), and STEAMED, in which the second E stands for entrepreneurship and the D for design (Kanadli, 2019). Therefore, both extensions of the STEAM approach could be taken into account in order to offer more holistic learning than is already proposed by the approach that we are dealing with in this intervention program.

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Word count: 7157

## 7. Annexes

April, 2021						
Monday 5 <sup>th</sup>	Tuesday 6 <sup>th</sup>	Wednesday 7 <sup>th</sup>	Thursday 8 <sup>th</sup>	Friday 9 <sup>th</sup>	Saturday 10 <sup>th</sup>	Sunday 11 <sup>th</sup>
			1 <sup>st</sup> session: The three little pigs			
Monday 12 <sup>th</sup>	Tuesday 13 <sup>th</sup>	Wednesday 14 <sup>th</sup>	Thursday 15 <sup>th</sup>	Friday 16 <sup>th</sup>	Saturday 17 <sup>th</sup>	Sunday 18 <sup>th</sup>
			2 <sup>nd</sup> session: The day the crayons quit			
Monday 19 <sup>th</sup>	Tuesday 20 <sup>th</sup>	Wednesday 21 <sup>st</sup>	Thursday 22 <sup>nd</sup>	Friday 23 <sup>rd</sup>	Saturday 24 <sup>th</sup>	Sunday 25 <sup>th</sup>
Feria de Abril (local holiday)						
Monday 26 <sup>th</sup>	Tuesday 27 <sup>th</sup>	Wednesday 28 <sup>th</sup>	Thursday 29 <sup>th</sup>	Friday 30 <sup>th</sup>		
			3 <sup>rd</sup> session: The pied piper of Hamelin			
May, 2021						
					Saturday 1 <sup>st</sup>	Sunday 2 <sup>nd</sup>
Monday 3 <sup>rd</sup>	Tuesday 4 <sup>th</sup>	Wednesday 5 <sup>th</sup>	Thursday 6 <sup>th</sup>	Friday 7 <sup>th</sup>	Saturday 8 <sup>th</sup>	Sunday 9 <sup>th</sup>
			4 <sup>th</sup> session: Goldilocks and the three bears I			
Monday 10 <sup>th</sup>	Tuesday 11 <sup>th</sup>	Wednesday 12 <sup>th</sup>	Thursday 13 <sup>th</sup>	Friday 14 <sup>th</sup>	Saturday 15 <sup>th</sup>	Sunday 16 <sup>th</sup>
			5 <sup>th</sup> session: Goldilocks and the three bears II			
Monday 17 <sup>th</sup>	Tuesday 18 <sup>th</sup>	Wednesday 19 <sup>th</sup>	Thursday 20 <sup>th</sup>	Friday 21 <sup>st</sup>	Saturday 22 <sup>nd</sup>	Sunday 23 <sup>rd</sup>
			6 <sup>th</sup> session: Lost and found			
Monday 24 <sup>th</sup>	Tuesday 25 <sup>th</sup>	Wednesday 26 <sup>th</sup>	Thursday 27 <sup>th</sup>	Friday 28 <sup>th</sup>	Saturday 29 <sup>th</sup>	Sunday 30 <sup>th</sup>
			7 <sup>th</sup> session: Robin Hood			
Monday 31 <sup>st</sup>						
June 2021						
	Tuesday 1 <sup>st</sup>	Wednesday 2 <sup>nd</sup>	Thursday 3 <sup>rd</sup>	Friday 4 <sup>th</sup>	Saturday 5 <sup>th</sup>	Sunday 6 <sup>th</sup>
			Corpus Christi (bank holiday)			
Monday 7 <sup>th</sup>	Tuesday 8 <sup>th</sup>	Wednesday 9 <sup>th</sup>	Thursday 10 <sup>th</sup>	Friday 11 <sup>th</sup>	Saturday 12 <sup>th</sup>	Sunday 13 <sup>th</sup>
			8 <sup>th</sup> session: The cow who climbed a tree			
Monday 14 <sup>th</sup>	Tuesday 15 <sup>th</sup>	Wednesday 16 <sup>th</sup>	Thursday 17 <sup>th</sup>	Friday 18 <sup>th</sup>	Saturday 19 <sup>th</sup>	Sunday 20 <sup>th</sup>
			9 <sup>th</sup> session: Martin and the chocolate cake			
Monday 21 <sup>st</sup>	Tuesday 22 <sup>nd</sup>					
	End of the school year					

Table 1. Implementation timeline. Source : original material.

Session nº:	1	Date of the session:	April 8 <sup>th</sup>	Duration:	100´
Title of the session:	The three little pigs				
Session outcome:					
This first session will serve as an introduction to the program. For that reason, the chosen story is a popular fable which children know for sure. Thus, throughout the session, students will listen to the tale and take part in a proposal of building a house for the little pigs. It will not be the first time they play to build something, but on this occasion, they should take into account some premises so as to overcome the challenge. In addition, they will be introduced to a kind of activity which will be frequent during the program in different ways and grading difficulty: coding. Hence, it is expected that this first lesson help students to get engaged in this program.					
Book synopsis:					
Once upon a time, there were three little pigs. Their mother told them to build their own houses. The houses should be strong and tough because in that region there were starving big bad wolves. Disregarding their mother advice, the first pig built his house of straw and the second pig of sticks. The third one, the big brother, decided to work hard to build a house where he could ward off hungry wolves and in which he can receive their brothers. In the meantime, the first and the second pigs were playing and having fun. However, the big bad wolf suddenly came out and chased both pigs in order to eat them. The first one hid in his straw house but the wolf blew down his house. The first pig ran to his brother's stick house, but the wolf also blew this house down. Both of them had to run to their big brother resistant house to shelter from the wolf. The wolf tried to blow it down, but it was impossible. The three pigs were safe in that house.					
Resources:					
Glue, white glue, scissors, straw, wood sticks, cardboard, Lego bricks, Fimo polymer clay, sugar cubes, stones, wood building blocks, fan, pig figures, fungible materials, recording sheet, codification mat. - Flexibility will be shown to students' desire to use other materials not included.					
Steps to be followed:					
1 <sup>st</sup>	Read the first part of “The three little pigs” story.				
2 <sup>nd</sup>	<p>Pose students a question. What pig do you think will build a house which best protect them from the wolf? Create a house in which the three little pigs can live.</p> <p>Conditions:</p> <ul style="list-style-type: none"><li>- The three little pigs must fit in.</li><li>- The house must withstand the wolf's puff.</li></ul> <p>Students will work on this task divided in small groups of five. They will be given a recording sheet (Figure 1) in which first of all they have to write down the material(s) they decide to use. Secondly, they will design the house. Once they have planned everything, they can start building.</p>				
3 <sup>rd</sup>	<p>Resume the storytelling: second part. Each time a pig run to other brother's house; the storyteller will stop to ask students to help the pigs to find the right path. Children will participate in a coding dynamic. Being the first time, they do something similar, in this session, it will be done in a big group. In the floor, a carpet will be rolled out. This carpet will be full of squares three of which are the houses of the pigs (Figure 2). One child will stand up on the square of the straw house and play the role of the first pig. The rest of the classroom, one by one, will indicate them the path to arrive at the stick house by telling him: one up, one down, one left or one right.</p> <p>When both pigs go to the big brother's house, the dynamic will be repeated adding</p>				



	difficulty. The storyteller will move the wolf along the different squares, so maybe they have to change their way home.
4 <sup>th</sup>	<p>Once the three pigs are in the house of the big brother, resume the storytelling: <b>third part</b>. Teste children's models of the houses using a fan as the wolf's puffs and checking if the three little pigs fit in. Considering the results of the different groups, start a conversation around the next questions:</p> <ul style="list-style-type: none"> <li>- Finally, which material do you think is better? What makes it better than others? (manipulate them if necessary when looking for the answer).</li> <li>- What do you think could be improved in the design of the houses?</li> <li>- Did you find any difficulty when designing/building/working on it?</li> </ul>

Table 2. 1<sup>st</sup> session: "The three Little Pigs". Source: original material.

Session nº:	2	Date of the session:	April 15 <sup>th</sup>	Duration:	100´
Title of the session:	The day the crayons quit				
Session outcome:					
<p>The outcome of this second session is to provoke children to think out of the box. Solutions for those problems that seemed not to have them, or new innovative ideas are achieved by thinking in a different way. It also provides with the ability to see things in a different way. However, children are used to do things always in the same way, following instructions and reaching all of them the same results. It is for that reason that in this session they are encouraged to use the things (crayons on this occasion) in a different way. If white colour is bothered painting empty spaces which are not even visible between other things, let's paint on a black paper. If green is bothered painting green trees, let's paint trees in other colours or, why not, let's build a multicolour tree sculpture using crayons of many different colours. Children will also do predictions, estimations and measure, as well as learn about the science of colours.</p>					
Book synopsis:					
<p>Poor Duncan just wants to colour in. However, when he opens the crayon box, he only finds letter with the same message: we quit! His colours are tired of always colouring the same objects, exhausted of colouring great surfaces, annoyed of been as a supportive actor or angry about been invisible in his drawings, among other things.</p>					
Resources:					
<p>Crayons, poster of all the colours, measuring graphic worksheets, white glue, paper, sharpener, cardboard, brushes, watercolour crayons. - Flexibility will be shown to students' desire to use other materials not included.</p>					
Steps to be followed:					
1 <sup>st</sup>	Read the story “The day the crayons quit”.				
2 <sup>nd</sup>	<p>Make predictions. Thinking on how they use colours, children will predict which may be the shortest or the longest crayon in the pencil holders of the classroom. In order to do that, there will be a poster (Figure 3) with all the colours, and they have to place an X in the three colours they think they use the most.</p> <p>Once all the students have done it, without counting the number of X in each colour, they will estimate which one may be the shortest and the longest, and therefore the less and the most used respectively.</p>				
3 <sup>rd</sup>	<p>Prove predictions and estimations. Children will work in groups. Each group will take a crayon of each colour and measure it creating a graphic on a worksheet (Figure 4). To do that, they will have to place the crayon above the line and draw the contour of the crayon.</p>				

	In the end, in the assembly, the teacher will hang the five worksheets (one per group) in the wall, next to the prediction poster, so they all can see the documents. The teacher will lead a discussion based on the data collected in which they will decide which colours are the least used, if they coincide with their predictions and why they use those colours less.
4 <sup>th</sup>	Think out of the box. Pose these questions: what can we do to use crayons in a new way? Is it possible to colour green dragons without using the green crayon? Can trees be of another colour than green? Do crayons only serve for colouring?
5 <sup>th</sup>	After the previous conversation, encourage students (divided in groups) to create their own artwork using crayons in a different and original way. They have to think about what they would have done in Duncan's place to make their crayons happy. They can colour a whole drawing mixing colours to obtain other colours, use crayons to build a sculpture, among other things. At the end, each group will present their artworks to the rest of the classroom.

Table 3. 2<sup>nd</sup> session: "The day the crayons quit". Source: original material.

Session nº:	3	Date of the session:	April 29 <sup>th</sup>	Duration:	100´
Title of the session:	The Pied Piper of Hamelin				
Session outcome:					
In this session will design, plan, choose materials, execute and assess their projects as professional of STEM do. They will also start coding using a programmable floor robot, so they will be learning directional language and programming. Regarding the A from the arts of STEAM, on this occasion, an artistic discipline which uses to be forgotten in education is going to be included: music. That way, music will be learnt while STEM is also implemented.					
Book synopsis:					
Hamelin was a wealth and miserly city. Once a plague of rats came to town. They thought it was a punishment for being that miserly. The rats cleaned everything out. They did not even leave foodstuff. The inhabitants were desperate, so the mayor offered fifty gold coins to the person who rid them of the plague. Many people tried to success for a long time, but nothing worked. Hamelin already seemed doomed to disappear from the map due to the plague. However, then, a man arrived at the town. He said he knew the solution to chase the rats out of Hamelin, but he needed some help. It was not the first time that this man had dealt with a plague of rats like that. He knew the solution was to play music and guide them to some remote place outside the city. <b>The inhabitants of Hamelin made him the instrument he needed and indicated on a map where he could go to get rid of those animals.</b> The piper managed to drive the rats out and returned to Hamelin to collect the reward. However, the mayor only gave him ten gold coins because he had only played one instrument. To punish them, the flute player began to play his instrument and all the children began to follow him. Hamelin was sad and silent. The inhabitants repented, sought the flautist to return the children, and gave him his reward. Since then, Hamelin stopped being a stingy city.					
Resources:					
Scissors, glue, straws, tape, boxes, strings, seeds, cardboard tubes, punch tools, paper plates, fabric, plastic spoons, shells, wood sticks, soda caps, cardboard, arrow pattern cards, coding mat. - Flexibility will be shown to students' desire to use other materials not included.					
Steps to be followed:					



1 <sup>st</sup>	Read the <b>first part</b> of the story “The Pied Piper of Hamelin”.
2 <sup>nd</sup>	Raise students the next issue: if that man says that the solution to chase the rats out of Hamelin is to play music, what do you think he needs from the inhabitants? The dialogue should lead to the conclusion that he needs a musical instrument. The requisite is that this instrument sounds. After that, the teacher will deploy a large number of musical instruments in the assembly, so children can explore them and what make them sound. They can ask questions or say what they think about those instruments.
3 <sup>rd</sup>	Create an instrument. Children will count with many different resources to build a musical instrument in groups. First of all, groups will plan their work by designing the instrument and choosing materials they are going to use. For that, they will use a worksheet (Figure 1). Once they have done it, they can start executing their plans. Before presenting it to the teacher and the rest of the group, they should check if it sounds and if it is properly built.
4 <sup>th</sup>	Read the <b>second part</b> of the story “The Pied Piper of Hamelin”. Reached the point where the Piper should make sound the instrument, children will do the same with their instruments. Then when the Piper needs to go to a remote place with the rats, children will have to guide him. In order to do so, they will be introduced to a new resource: a programmable floor robot. Coding it is very similar to the coding activity they performed in the first session. Divided into the same groups as before, they have to use the pattern cards (Figure 5) to design the path the robot should follow. Then, they have to introduce the instructions by pressing the different direction buttons and, in the end, press “go!”. That way, they will see how their robots go from Hamelin to the remote place. This will be done in a similar mat (Figure 6) to the one used in session one.
5 <sup>th</sup>	Read the <b>third part</b> of the story “The Pied Piper of Hamelin”.

Table 4. 3<sup>rd</sup> session: "The Pied Piper of Hamelin". Source: original material.

Session nº:	4 & 5	Date of the session:	May 6 <sup>th</sup> & 13 <sup>th</sup>	Duration:	100' + 100'
Title of the session:	Goldilocks and the three bears				
Session outcome:					
<p>Since the program is already well advanced, these two sessions will be considerably more complex. Thus, to start, children will have to create not one but three final products. Consequently, not only do they have to think more about how to it, the design and materials, but also they have to organise themselves better within the groups. Therefore, the challenge is bigger than in previous sessions.</p> <p>Furthermore, a new programming tool is added. This tool, Scratch Junior, allows for coding directional instructions, but also interaction among characters which they have to choose; a background; dialogues by writing or recording, among other things. That way, it is much more complex.</p>					
Book synopsis:					
<p>A girl, called Goldilocks, saw a house in the forest and entered. It was empty but there was a table with its chairs and three appetizing bowls of soup. She was hungry and decided to taste the bowls of soup until she taste the smallest one and ate the whole of it. Then she was tired and decided to rest in a chair. Two of them were too big for her, so in the end she chose the smallest one. After resting in the chair, she was still sleepy. She went upstairs and found three beds. Two of them were too big and tough, so she finally</p>					

slept in the smallest one. When the owners of the house, a family of bears, returned to their house, they discovered that someone had been there, tasting their soups, trying their chairs and... Someone was sleeping in Baby Bear's bed. They awoke the girl and asked her why she had done that things in their house. Finally, Baby Bear and Goldilocks befriended, and Daddy and Mummy Bears were thinking what to do with Goldilocks since they only had three bowls, three chairs and three beds.	
<b>Resources:</b>	
Glue, white glue, scissors, tempera paint, playdough, Fimo polymeric clay, clay, Lego blocks, lingual depressants, clothes pegs, tablets. - Flexibility will be shown to students' desire to use other materials not included.	
<b>Steps to be followed:</b>	
1 <sup>st</sup>	Read the story of "Goldilocks and the three bears".
2 <sup>nd</sup>	Pose the question: at the end of the story, the Bear family is happy having Goldilocks there, but they are worry about the lack of a bowl, a chair and a bed. What would you do to solve this problem?
3 <sup>rd</sup>	Build the bowl, the chair and the bed for Goldilocks taking into account the size of her before creating those objects. They will have a jointed Goldilocks doll to test their creations. For each of the objects, the different groups in which children work will have to complete a worksheet in which they will include the materials, the design, the name of what they are creating (Figure 1).
4 <sup>th</sup>	Presentation of their creations. The groups will show what they have built to their teacher and classmates. They will tell them what they think is the best part of their objects and if there is something they think could be improved. Their classmates can interact with the groups.
5 <sup>th</sup>	Scratch Junior. Children will have free time to explore Scratch Junior in the tablets. The teacher will observe and guide them; as well as answer their questions.
6 <sup>th</sup>	Remember previous session. The teacher will ask if they remember the end of the story "Goldilocks and the Three Bears". They will talk about how they think that this story continues.
7 <sup>th</sup>	Children will create a sequel story to tell what happens after Goldilocks have her own bowl, chair and bed in the Three Bears' house using Scratch Junior.
<b>Note:</b>	Two sessions are explained in this chart. Steps from 1 <sup>st</sup> to 4 <sup>th</sup> will be implemented in a first session and steps from 5 <sup>th</sup> to 7 <sup>th</sup> in the next session.

Table 5. 4<sup>th</sup> and 5<sup>th</sup> sessions: "Goldilocks and the Three Bears". Source: original material.

Session nº:	6	Date of the session:	May 20 <sup>th</sup>	Duration:	100´
Title of the session:	Lost and Found				
Session outcome:					
<p>The story chosen for this session will allow learners to experiment with water and objects by manipulation and testing so as to discover what kind of materials do float. Besides, they will have the opportunity to discover how to generate movement by testing different processes and resources. Taking into account the resources they count with and mean of transport (water), they will probably conclude that it is wind one of the agents which generates wind. However, if they come up with another hypothesis, it will be welcomed and brought to class.</p> <p>In addition to this, similar to previous sessions, students will have to plan their performance and design their products recording all this information on the sheets created</p>					

for this purpose. In the end, they will have to test their final products.	
<b>Book synopsis:</b>	
Once, a boy found a sad Penguin who started to follow him. He did not know where it came from. And nobody seemed to know either. He discovered that the Penguin came from the South Pole, but how to get there? He went to the harbour, but he was too small to be heard there. So, together, they built a small boat, tested it for size and strength and drove to the South Pole; not without earlier packed everything they will need. The way was long, but the boy spends it telling stories that the Penguin listened to silently. They floated through the good weather and bad until they came to the South Pole. The boy was delighted but the Penguin said nothing. He looked sad again. The boy said goodbye and floated away. But the Penguin looked sadder and sadder. The more the boy thought, the more he realised the big mistake he was doing. The Penguin was not lost, but lonely. Quickly he turned around and reached the South Pole again. But the Penguin was not there anymore. The boy set off for home. Then he saw something in the water. Closer and closer he got; he saw the Penguin. They went home together talking of wonderful things all the way.	
<b>Resources:</b>	
Glue, white glue, scissors, tempera paint, playdough, Fimo polymeric clay, clay, Lego blocks, lingual depressants, clothes pegs, fabrics, paper, stones, wood building blocks, macaroni, fan, manual fans, balloons, fly swatters. - Flexibility will be shown to students' desire to use other materials not included.	
<b>Steps to be followed:</b>	
1 <sup>st</sup>	Read the first part of the story "Lost and Found".
2 <sup>nd</sup>	Build a boat for the boy and the Penguin. Children will work in small groups. Each group will have a great variety of resources and a bucket full of water where they could teste which material float in order to choose. They will also need to think about how this boat is going to move (for example, they can move it using a fan or a balloon). Before starting to build the boat, they will have to fulfil the recording sheet (Figure 1). The teacher will indicate the steps to follow, thus reminding them to investigate which material floats and which does not. They will also have to record in a worksheet the materials which float and does not (Figure 7).
3 <sup>rd</sup>	Discuss about the objects which float and do not float and make hypothesis about it in class group.
4 <sup>th</sup>	Read the second part of the story but stopping in order to help the characters to arrive. Children will have to move their boats from the harbour to the South Pole. In order to do that, there will be a small inflatable swimming pool in which the extremes, properly characterised, will represent the harbour and the South Pole. Children will have to make their boats move from the harbour to the other extreme.
5 <sup>th</sup>	Read the third part of the story. Let the children guide their boats back to the port.

Table 6. 6<sup>th</sup> session: "Lost and Found". Source: original material.

Session n°:	7	Date of the session:	May 27 <sup>th</sup>	Duration:	100´
Title of the session:	Robin Hood				
Session outcome:					
During this seventh session, students will have the opportunity to build as well as test something that they conceive as a toy, so that engagement in this session will be easier to					

reach. Moreover, they will have to return to coding activities using the programable floor robot. It will be a little higher level than previous sessions so as to progress in this kind of tasks.

Besides, learners will have to think about the use of objects and their versatility in order to build one or two products that serve to go up and down as well as to slide things. To do this, they must research, share ideas and plan their work. Finally, students will be introduced to equitable distribution, the main step to later understand the concept of the mathematical operation of division in Primary Education.

#### Book synopsis:

Since King Richard had to go to war, his brother Prince John has not stopped raising taxes on the inhabitants of Nottingham. Robin Hood and his friend Little John robbed him to return his money to the poor.

Once, when they saw the prince's carriage through the Sherwood forest, they decided to dress up as gypsies and approach the prince with the excuse of reading his hand. However, they took advantage to rob him. Realizing it, he ordered them to be chased, but they were already too far away.

To catch Robin Hood, Prince John decides to hold an archery tournament, a discipline Robin Hood was adept at. The prize would be a kiss from Lady Mariam, Prince John's niece, with whom Robin Hood is in love. Robin Hood and Little John decide to go disguised so that they are not discovered. **Robin Hood has to face the Nottingham Sheriff, the person who collects taxes and hates him. After many Sheriff cheats, Robin Hood wins the tournament.**

**When going to collect the prize, Robin Hood is discovered, and everyone begins to fight. In the end, Robin Hood and his friends win, Robin Hood asks Lady Mariam to marry him, and they all go into the woods to celebrate. Meanwhile, Prince John thinks how to get revenge.**

**Prince John and the Sheriff continue to raise the taxes they levy on the people of Nottingham and take prisoners who cannot afford them. Robin Hood decides to help and goes to the castle. There, first, he frees all those who were imprisoned for not paying taxes and then he has to go up to the tower where Prince John sleeps surrounded by bags full of gold coins. Robin Hood manages to climb and take the coin bags down to where Little John was.**

**When he tried to leave, Robin Hood met Prince John and the Sheriff who had just woken up. They set fire to the tower and Robin Hood had to jump into the pit to save himself. Once down, he swam to the other side and met his friends. He handed out the money and they celebrated that Robin Hood and Lady Mariam were getting married. King Richard also returned, and Nottingham became a prosperous place again.**

#### Resources:

Different sized wood sticks and branches, string, hangers, tape, cardboard tubes, scissors, glue, white glue, recording sheet, coding mat, programmable floor robot, fret saw, hand auger, cardboard, lingual depressants, bottle caps, pool noodles, coins. - Flexibility will be shown to students' desire to use other materials not included.

#### Steps to be followed:

1<sup>st</sup> Read the **first part** of the story "Robin Hood".

2<sup>nd</sup> Robin Hood needs an arc so as to win the prize and kiss Lady Mariam. Help him to build the best bow and an arrow holder. Children will count with multiple resources to choose among (wood sticks, hangers, string, elastic, carton pipes, etc.)

As always, the first step will be to choose the materials they are going to use and then write it down and design the bow and the arrow holder (Figure 1). Then, they

	can start building it. However, if the groups want to investigate how bows are, it is a great moment to guide them when using Google to find some images. When building it, they could use some tools such as <a href="#">fret saws</a> or <a href="#">hand augers</a> so that the teacher will have the control of tools and children will use them under supervision and using proper protection. Finally, each group will test it bow and assess if it works or if it should be fixed.
3 <sup>rd</sup>	Read the <b>second part</b> of “Robin Hood”.
4 <sup>th</sup>	Robin Hood wants to enter the castle to free the inhabitants of Nottingham and recover the money stolen by the prince. To do this, he must find the way without going through the castle guards to avoid being discovered and captured. Children will have to use the programmable floor robot to indicate Robin Hood the correct way. For that, there will be a coding mat inspired in a castle (Figure 8).
5 <sup>th</sup>	Help Robin Hood climb the tower and slide the money bags down to where Little John is. Children will have to choose resources, write in down in the worksheet and design what they are going to build. They will have to think on what Robin hood needs to go down and to slide money bags. Is there something he could use to both things or do they have to build two different things, one to go up and another one to slide things? To prove if their products work, they will have a tower per group. Towers will be made of milk bricks with the picture of the tower attached at the front.
6 <sup>th</sup>	Read the <b>third part</b> of “Robin Hood” and help Robin Hood to equitable distribute the money among the inhabitants of Nottingham.

Table 7. 7<sup>th</sup> session: "Robin Hood". Source: original material.

Session nº:	8	Date of the session:	June 10 <sup>th</sup>	Duration:	100´
Title of the session:	The cow who climbed a tree				
Session outcome:					
The pursued objective of this session is encouraging children to assess their own products and be able to decide if changes are required. In this sense, they will have to organise their work as they would have in previous sessions. The difference will lie in the fact that, on this occasion, they will have the opportunity to make as many changes they consider necessary before showing it to the rest of the classroom. In order to do that, they should be aware of the convenience of testing things over and over again until they are pleased with the result.					
Book synopsis:					
Tina is a cow. But she is not like the other cows. Unlike her sisters, she was not only interested in fresh grass. She wanted to discover and explore everything. Once, while Tina explored the forest, she decided to climb a tree. At the top, she found a dragon. They became friends. Back in her house, she told her sister about the dragon, but they said it was ridiculous, and cows did not climb trees. Next morning, Tina left a note for her sisters: “I will be flying with the dragon”. Tina’s foolishness had gone too far. They decided to look for Tina and take her back home. But, once in the forest, they saw a sign on a tree which said: “flying classes at the top”. They could not believe it. But they climbed and saw Tina. It was impossible! She was flying (using a parachute, of course)”. Tina asked her sisters if they wanted to fly.					
Resources:					
Plastic trash bags, small bags, tissues, twine, scissors, hole punch, coding mat, programmable floor robots, glue, white glue, tape, paper, cardboard, bottle caps.					



Flexibility will be shown to students' desire to use other materials not included.	
<b>Steps to be followed:</b>	
1 <sup>st</sup>	Read the <b>first part</b> of the story "The cow who climbed a tree".
2 <sup>nd</sup>	Tina's sisters do not know how to arrive at the forest. Help them. Students will have to use the programmable floor robot to indicate Tina's sisters the correct way. For that, there will be a coding mat inspired in the forest (Figure 9).
3 <sup>rd</sup>	Read the <b>second part</b> of the story "The cow who climbed a tree".
4 <sup>th</sup>	Pose the following questions and reflect: can we fly? Can cows fly? Why not? What kind/groups of animals can fly? What could we do to help Tina's sister to fly?
5 <sup>th</sup>	Probably, the conclusion students will arrive at is that they can create a parachute to Tina's sisters because the last page of the story shows Tina and other animals flying using a parachute. However, if other ideas are suggested, children will be encouraged to develop the one they prefer talking previously with them about the viability of it new idea. During this task, as always, students will have to complete the recording sheet (Figure 1) and, in the end, they will have to test their products and fix them as many times as they consider is necessary to make it works.
6 <sup>th</sup>	Finally, the class group will go to some safe and high place of the school (for example, a fenced exterior corridor) from which the students could throw their products and watch happens.

Table 8. 8<sup>th</sup> session: "The cow who climbed a tree". Source: original material.

Session nº:	9	Date of the session:	June 17 <sup>th</sup>	Duration:	100'
Title of the session:	Martin and the chocolate cake				
Session outcome:					
It is the final session of the intervention program. Thus, the story has been chosen to add a festive touch to it without setting STEAM apart. Cooking is considered a science and an art. Therefore, even though on this occasion, it is not about solving a problem of the story, but cooking a cake for themselves, it is a completely acceptable STEAM approach. Children will be able to plan, design, and implement something for their own. It will make them use measures, understand some process of food and think of cause-effect situations. All of this will make them feel curiosity and engagement in the lesson. Furthermore, this session will show students a new field of everyday life in which STEAM disciplines are also included.					
Book synopsis:					
Martin is a boy who lives with his two fathers. The day of one of his fathers' birthday, he wants to bake a cake as a present for him. However, he does not know to cook, so it becomes a total disaster. When Daddy arrives at the kitchen and realise the disaster, he offers his help to Martin who accepts. Then, they start cooking the chocolate cake following the recipe carefully and protecting themselves. When Dad arrives, they surprise them with the cake and some balloons. They taste the cake and it is delicious! Martin tells him it is because of their secret ingredient: love.					
Resources:					
Aprons, napkins, tablecloth, wipe, soap, rectangular moulds, rectangular and round cookies made of cardboard, normal and free-salt bread, ingredients of the recipe (annex 19).					
Steps to be followed:					

1 <sup>st</sup>	Read the story “Martin and the chocolate cake”.
2 <sup>nd</sup>	Ask students if they would like to do a cake like the one Martin cooks.
3 <sup>rd</sup>	<p>Show students the recipe (Figure 10) and ask them about how to organise the work. What is the first thing to do before starting a recipe?</p> <ul style="list-style-type: none"> <li>- Healthy and safety. It is important to reflect on how to protect ourselves when doing this kind of activities as well as protect our health by keeping everything clean.</li> <li>- Read and prepare the list of ingredients and cooking utensils. <ul style="list-style-type: none"> <li>○ Taking into account the rectangular mould that they have among the utensils, pose students the next question: why does the recipe say that it is better to use rectangular cookies instead of round cookies? Using rectangular and round cookies made of cardboard and the mould, check it.</li> <li>○ Why do you think salt is an ingredient in a sweet recipe? To make children understand that salt enhances flavour, the best option is through experimentation. Give children a bit of normal bread and a bit of free-salt bread. Discuss the difference.</li> </ul> </li> </ul>
4 <sup>th</sup>	Cook the recipe following the instructions. Children will work divided into small groups while the instructors guide them.
5 <sup>th</sup>	Test the result after waiting the time it should be in the fridge: taste the cake.

Table 9. 9<sup>th</sup> session: "Martin and the chocolate cake". Source: original material.

# STEAM challenge

Names:

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Resources we use:

Our design:

Figure 1. Recording worksheet. Source: original material.





Figure 2. Coding mat "The Three Little Pigs". Source: original material.



Figure 3. Colours poster. Source: original material.

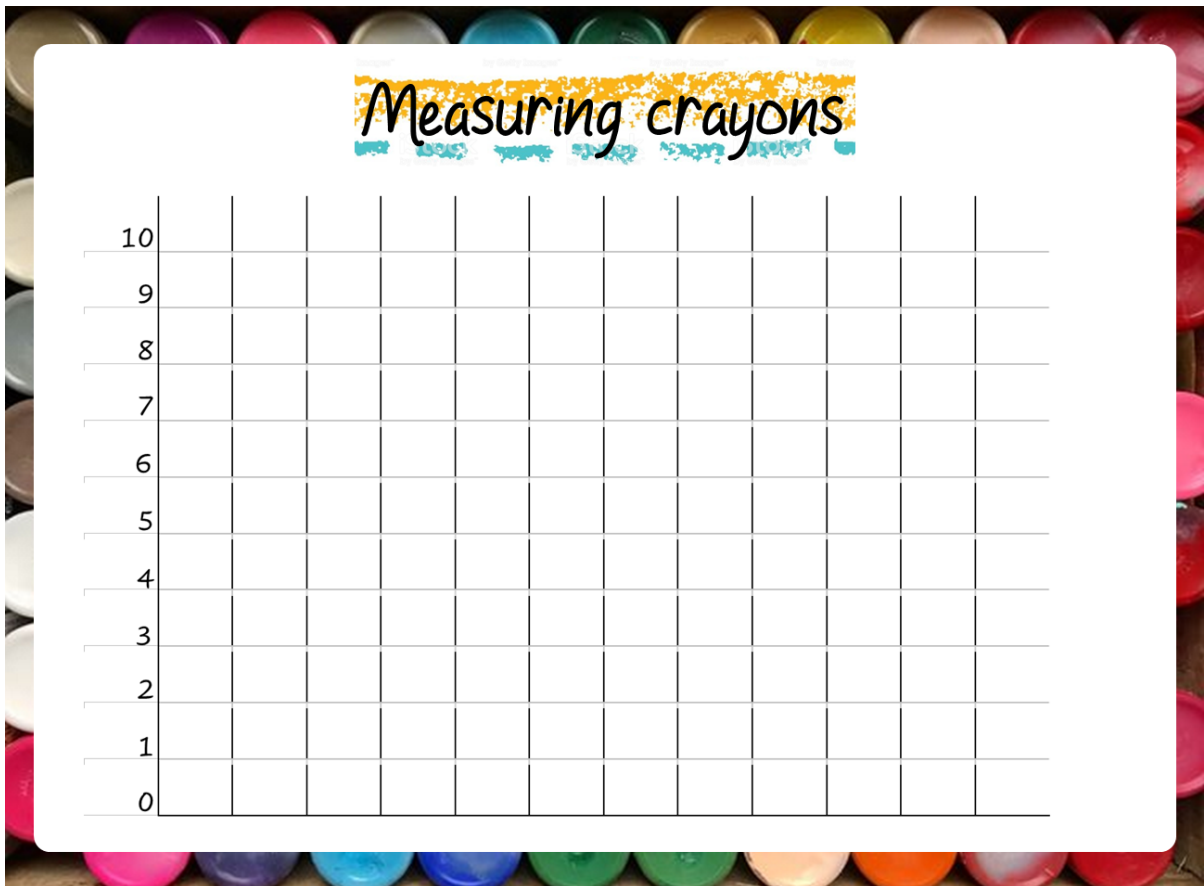


Figure 4. Measuring crayons graphic worksheet. Source: original material.

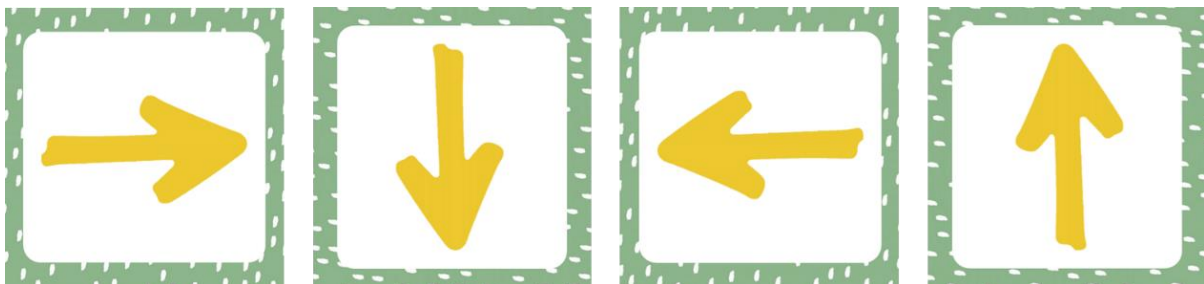


Figure 5. Arrow pattern cards. Source: original material.

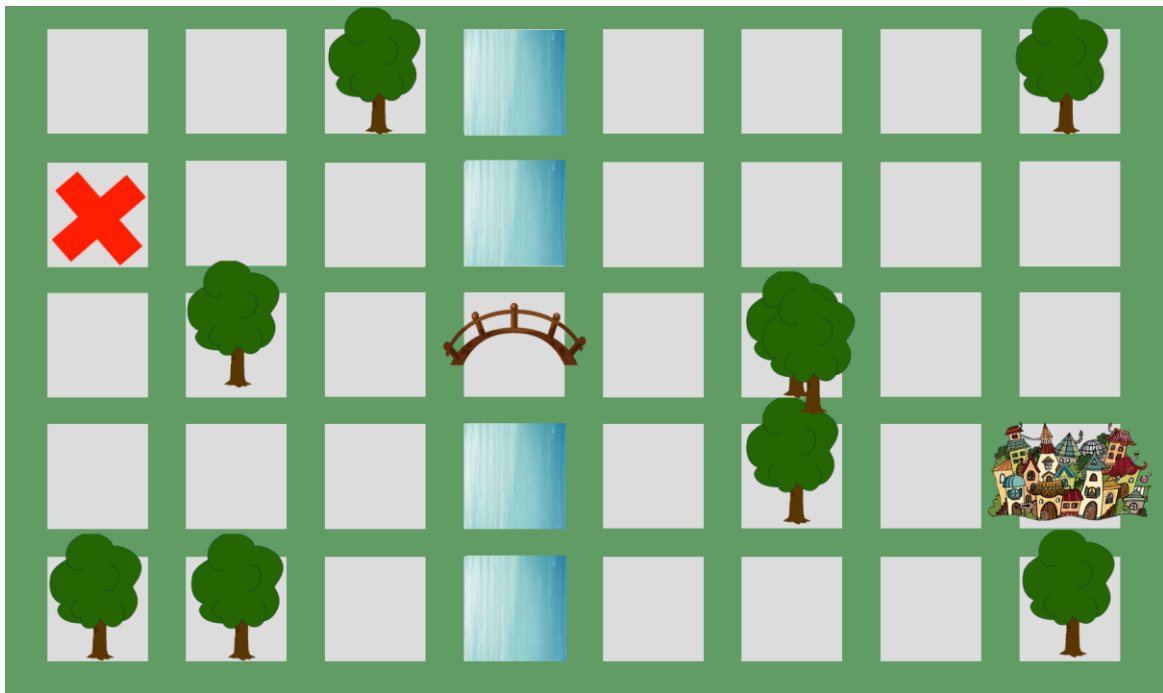


Figure 6. Coding mat "The Pied Piper of Hamelin". Source: original material.

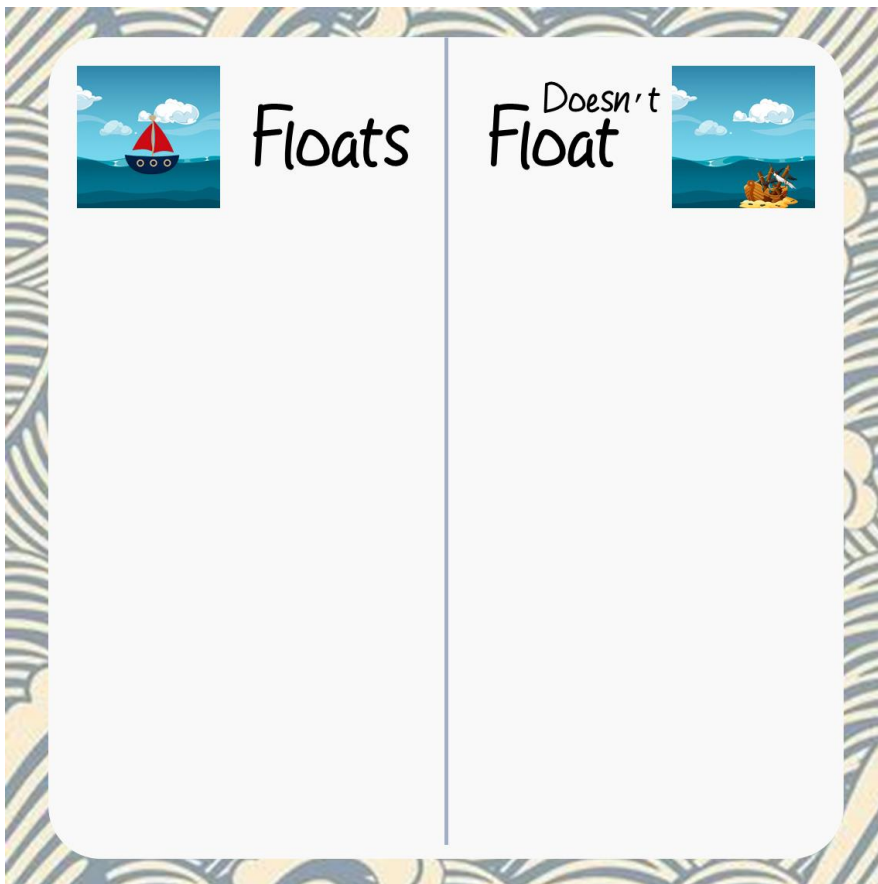


Figure 7. Materials which float and do not float worksheet. Source: original material.

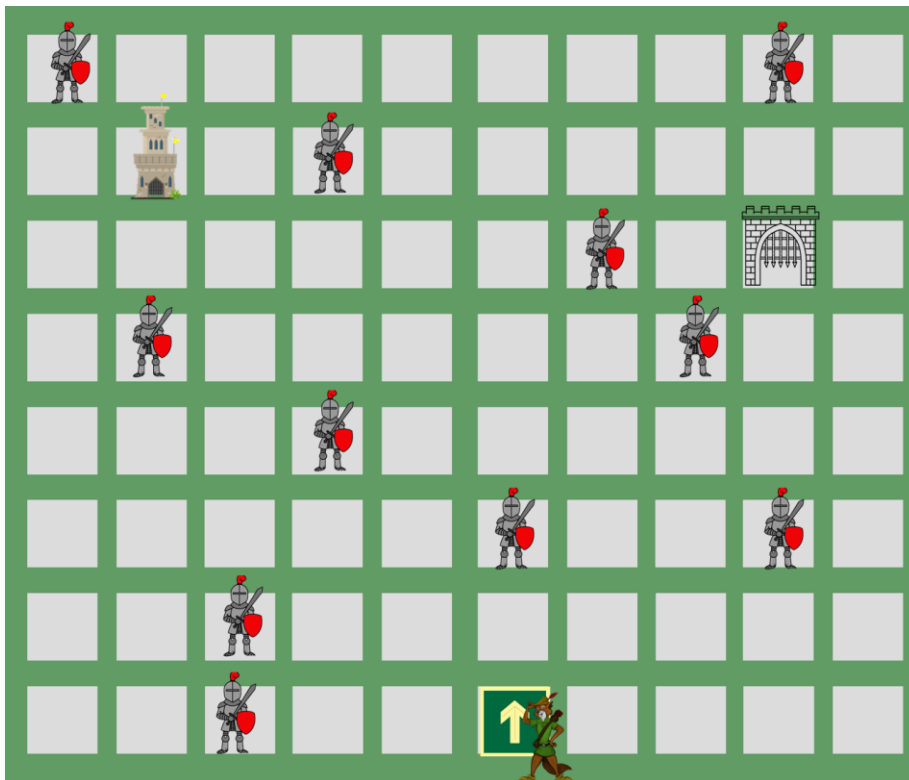


Figure 8. Coding mat "Robin Hood". Source: original material.

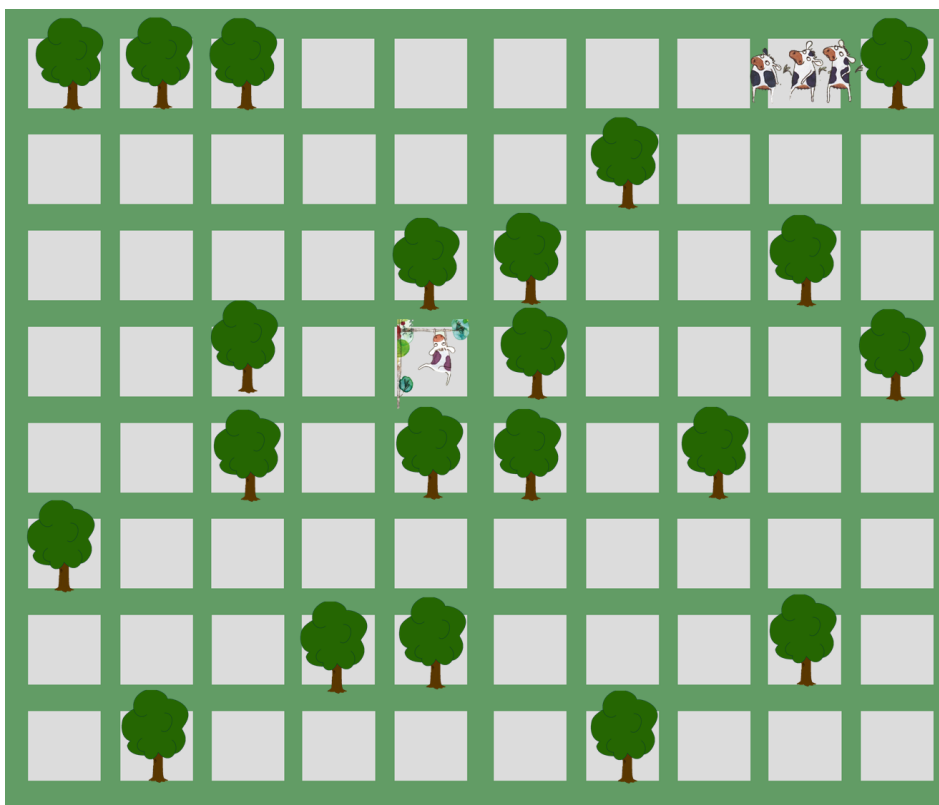


Figure 9. Coding mat "The cow who climbed a tree". Source: original material.

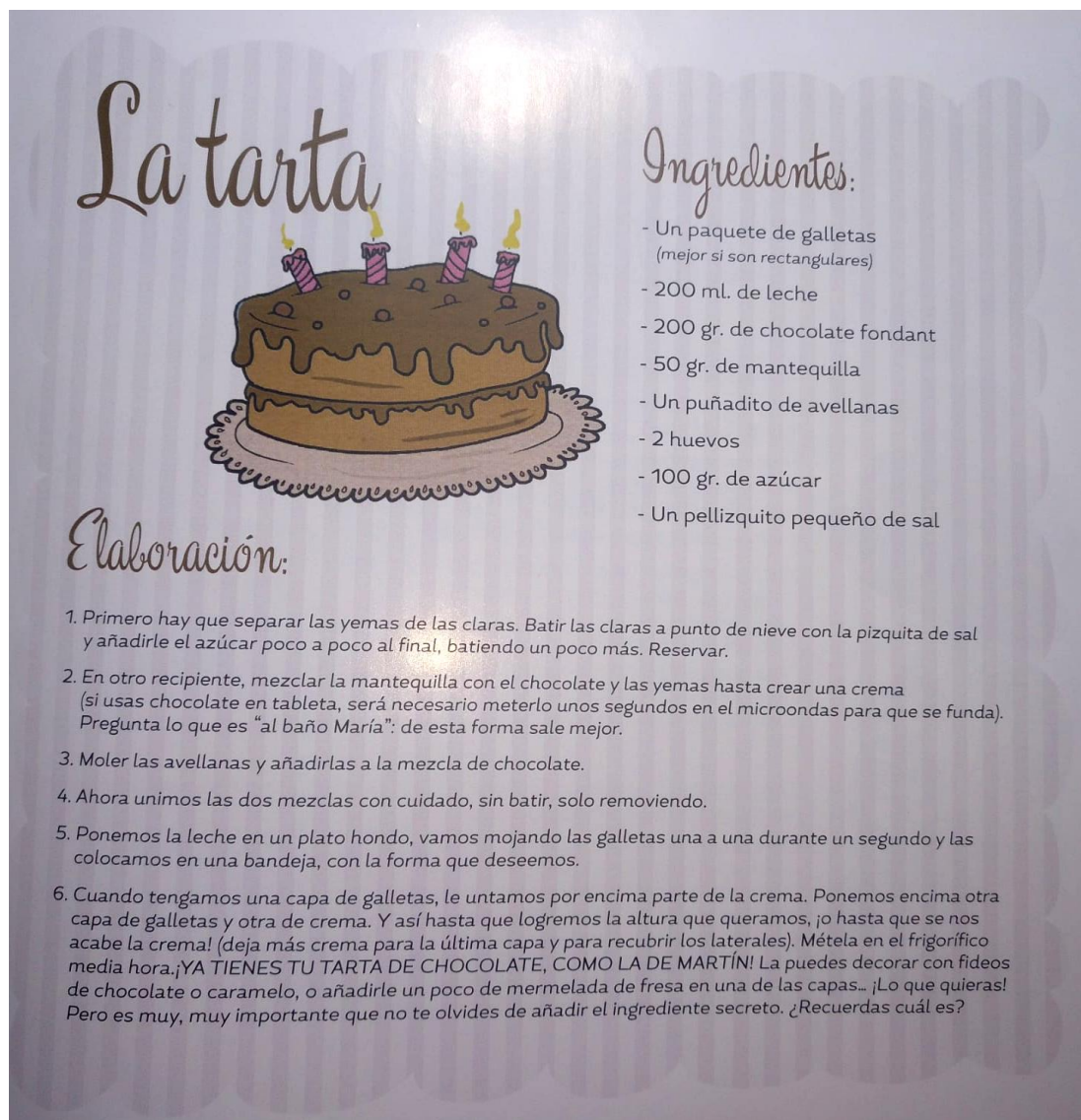


Figure 10. Cake recipe. Source: Martin and the chocolate cake illustrated album, by Julián Guerra López (Publisher: Samarcanda).

Title	Author	Year	Publisher
Lost and Found	Oliver Jeffers	2005	Harper Collins
The day the crayons quit	Drew Daywalt	2013	Penguin Young Readers Group
Martin and the chocolate cake	Julián Guerra López	2016	Samarcanda
The cow who climbed a tree	Gemma Merino	2015	Albert Whitman
*The rest of the stories are folk tales transferred through oral transmission, so no published resource has been consulted.			

Table 10. Published resources. Source: original material.





Figure 11. Plickers code Example. Source: Instagram post (Josune Rodríguez-Negro, 2019).



Figure 12. Assessment corner Example: Source: Instagram post (Josune Rodríguez-Negro, 2019).

Name of the project:				
Implementation date:		Target group:		
Item	Always	Often	Seldom	Never
The offer of activities includes all the STEAM focus areas in a balanced way throughout the sessions				
Comments:				
There has been an increase in the use of creativity in solving challenges (visible in the ideas proposed by the group, and final products result) throughout the sessions compared to the creativity professed by students outside the project				
Comments:				
In each session, situations have been created that foster the development of skills necessary for solving real problems (decision-making, self-evaluation, critical thinking, conflict resolution, collaboration, communication, use of technology, flexibility, leadership)				
Comments:				
Interaction among equals has encouraged group work always based on respect and acceptance of the ideas of others				
Comments:				
The evaluation of the sessions by the target group has been mainly positive				
Comments:				
The resources used were varied and appropriate to the target group and the activities proposed				
Comments:				
The target group has shown interest toward the tasks of the sessions				
Comments:				
The organization and temporal distribution has been appropriate				
Comments:				

Table 11. Estimation scale. Source: original material.